Biosketch

Michael R. Hoffmann
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Prof. Michael Hoffmann received a BA degree in chemistry in 1968 from Northwestern University and a PhD degree in chemistry from Brown University in 1974. In 1973, he was awarded an NIH post-doctoral training fellowship in Environmental Engineering Science at the California Institute of Technology. Hoffmann has served as a Professor of Environmental Engineering and Environmental Chemistry since 1975. From 1975 to 1980, he was member of the faculty at the University of Minnesota and since 1980 a member of the faculty at Caltech (Engineering & Applied Science). Dr. Hoffmann has published more than 260 peer-reviewed professional papers and is the holder of 7 patents in the subject areas of applied chemical kinetics, aquatic chemistry, atmospheric chemistry, environmental chemistry, catalytic oxidation, heterogeneous photochemistry, sonochemistry, electrochemistry, and pulsed-plasma chemistry. Dr. Hoffmann has served as the Chairman of the Gordon Research Conference, Environmental Sciences: Water and as an Associate Editor of the Journal of Geophysical Research. He is currently on the Editorial Boards of *Environmental Science and Technology* and the *Journal of Physical Chemistry*. He also serves on the Scientific Advisory Board of the Max Planck Institute for Chemistry in Mainz. In 1991, Dr. Hoffmann received the Alexander von Humboldt Prize for his research and teaching in environmental chemistry. In 1995, Dr. Hoffmann was presented with the E. Gordon Young Award by the Chemical Society of Canada in recognition of his work in the field of environmental chemistry. He has also served as a Distinguished Lecturer at the Hebrew University (Jerusalem), the University of Sao Paulo (Brazil), and the University of Buenos Aires. In 2001, Dr. Hoffmann was presented with the American Chemical Society Award for Creative Advances in Environmental Science and Technology for "his fundamental and lasting contributions to the science of aquatic chemistry, to the development of aquatic remediation processes, and to understanding heterogeneous and multiphase processes in the atmospheric environment." Prof. Hoffmann was honored recently as "Davis Memorial Lecturer in Chemistry" at the University of New Orleans, the "Dodge Distinguished Lecturer in Chemical Engineering" at Yale, and the "Harold Johnston Distinguished Lecturer in Physical Chemistry at UC-Berkeley." Most recently, he was awarded the 'Jack E. McKee Medal,' for his contributions in the field of environmental remediation by the Water Environment Federation and an 'Alexander von Humboldt Senior Scholar Award' by the Alexander von Humboldt Foundation.

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Pex is Polyethylene, which is widely accepted for potable water applications

Polyethylene has a long history in plastic pipe and food packaging. The simplest form of polyethylene is HDPE. It consists of long uninterrupted chains of carbon atoms with two Hydrogen atoms attached to each carbon, and the carbon atoms are subsequently covalently bonded to each other. This straight-line structure allows it to be heated and cooled into large polymer crystals. These crystals add strength and stiffness to the material. The formation of these crystals is a reversible process that can be repeated over and over again hence the designation thermoplastic material. If less hardness is desired, and ductility is more important, as is the case of plastic bags or packaging, some of the carbon atoms are rearranged so that they appear as branches or pieces of polyethylene attached with covalent bonds to the main chain. This makes it more difficult for the chain to fold into crystals and therefore makes them more pliable and less dense. These grades are referred to as medium density polyethylene (MDPE), low-density polyethylene (LDPE), and linear low-density polyethylene (LLDPE). If higher temperature resistance is required, for example, hot water applications, the sub-groups or side chains from adjacent polyethylene chains are covalently connected together. This is accomplished in one of several commercial methods. Thermosetting or cross-linking prevents the polyethylene chains from slipping or sliding by one another. This is generally desired in parts requiring high temperature resistance properties. These forms are thermally set, and are referred to as cross-linked polyethylene or PEX.

The continuum of polyethylene resin has always enjoyed wide acceptance in food packaging and potable water applications. This is in no small part due to the chemical stability and simplicity of these materials, as there are no known room temperature solvents for polyethylene. These materials are all essentially simple single covalently bonded structures holding together the polymer chain. The most stable and desirable form is PEX. Its cross-linked nature prevents any solvent attack regardless of the temperature, and therefore is used for body implants. In my opinion, although all polyethylene have identical chemical roots and stabilizer additives, and common processing techniques, the cross-linked form should be used wherever possible because it gives the greatest assurance of being able to resist transient heat loads and unexpected introductions of strong oxidizing agents. All polyethylene polymers provide an excellent non-polar barrier to permeation, extraction and other forms of intermolecular mass transfer.

In conclusion PEX is polyethylene and all forms of polyethylene, including PEX, HDPE, MDPE, LDPE, and LLDPE, are accepted for potable water applications. This material represents the safest material choice when compared to metals, ceramics, or other polymers for this application.

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Attention: Stan Nishimura
California Building Standards Commission
2525 Natomas Park Drive
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From: John Messick, PE

Subject: 45-Day Written Comment Period Re. Adoption of the 2000 Edition of the Uniform Plumbing Code (UPC) with California Amendments into the California Code of Regulations Title 24, Part 5.

COMMENT:

I have prepared these comments as a concerned resident of the State of California regarding the Commission's recent proposed changes to adoption of the 2001 California Plumbing Code, Title 24, Part 5, California Code of Regulations; and more specifically, for the modified text that does not allow the use of PEX piping for applications under the authority of the Building Standards Commission, the Department of Health Services, and the Department of Food and Agriculture. Prior to the previous comment period, the Commission had proposed the adoption of the 2000 UPC that included PEX. Based on only one comment received from an attorney, Mr. Dan Cardoza of Adams, Broadwell, Joseph & Cardoza representing the California State Pipe Trades Council ("the Council), the Commission has modified text in the 2000 UPC to exclude PEX.

It is my belief that Mr. Cardoza has misrepresented the PEX piping picture to the Commission. Mr. Cardoza is not an authority on PEX, has no experience with PEX, and cites no studies or information to backup his statements. The Council has an obvious interest in preventing PEX as an alternative because of its less costly labor installation (these savings with PEX benefit California consumers).

With regard to my background, I have worked in the plumbing industry, and have direct experience installing PEX. I have a Masters Plumbing License, and a Bachelor of Science degree in Chemical Engineering and Professional Engineers License. I was the project manager for a consulting firm in Puerto Rico that provided projects and consulting for water distribution systems to "PRWSA", the Puerto Rico Water and Sewer Authority, including Environmental Impact Reports. In addition, I have served as Sanitary Engineer for a major municipality.

General, Common Sense, Application of PEX

PEX is nothing more than polyethylene (PE) that has been reinforced by crosslinking the molecules. The basic chemical structure is the polyethylene molecule. PE is used extensively in the Foods industry. Let me ask this question: Would you rather have your milk setting in a copper (with soldered joints) jug, or in the currently acceptable method of plastic, PE, containers? Why are many "metallic" container coated with PE? Answer: Because of the concern for metal contaminants.

PEX piping systems are installed completely without the use of solder or flux (contains both hazardous and toxic compounds), or solvents (which are used for CPVC). This was done by design to eliminate both worker and consumer exposure to these chemicals.

Presumably, all piping sytems have advantages and drawbacks. Clearly there are areas of concern for some people with copper and other metallic piping systems and also areas of concern with CPVC type systems. Perhaps some people have some areas of concern with PEX piping systems. The informed residents and home buyers in the state of California should have the option of purchasing or replacing plumbing systems with PEX unless some fatal flaws are identified in PEX piping. The fact that PEX piping does not have fatal flaws has been demonstrated in the open market place where PEX piping has been shown to be a preferred system by plumbers, contractors, and consumers. For example, in Las Vegas (the fastest growing city in the U.S.), PEX is used in about 80% of new home construction, and 90% of plumbing replacement (including copper) projects. Many other areas of the U.S. have the same experience. PEX has been installed successfully in some California homes, due mostly to failures with copper piping. Is the Commission not going to allow this option for future California residents? Should informed plumbers not have the option to install a non-hazardous PEX piping system?

It need not be shown that PEX is perfect in every way to justify its inclusion in the code. Nevertheless, there are erroneous allegations and statements in Mr. Cardoza's letter which need to be corrected.

The next comment addresses topics that were raised by Mr. Cardoza, and were used by the Commission to strict PEX from the code.

Requirement for a California Environmental Quality Act (CEQA) Review

The *rationale* used by the Commission to strike PEX from the proposed adoption in the Code was the fear raised by Mr. Cardoza that the adoption of PEX would trigger the CEQA.

First, I would like to point out that no other citizen or trade advocate groups opposed the original proposed adoption that include PEX. Mr. Cardoza states that the Council has a long-standing record of participating with others in the prevention of plastic pipe systems in California. In his words, these include labor organizations, environmental and consumer groups, plumbing and mechanical contractors, public officials and others. These groups are not opposing the adoption of PEX.

Mr. Cardoza references the analysis of Thomas Reid Associates indicating the use of PEX may result in significant public health and environmental impacts. Unfortunately, I was not able to obtain a copy of the referenced document (the document was not made available via the Commissions website or CD's that were distributed). However, in making these sweeping allegations, not one specific adverse impact was identified. One would think that if the study had concerns, at least Mr. Cardoza would have highlighted the major concerns. Also, this study was apparently done many years ago, and does not reflect the current body of evidence supporting the use of PEX.

Second, PE (including PEX because in building materials other than plumbing, crosslinked PE is substituted directly for PE) is approved for many uses, including water distribution systems outside the house.

Third, Mr. Cardoza inappropriately lumps all plastic pipe together. This is equivalent to lumping all metallic pipe together. Does Mr. Cardoza believe that it's fair to lump copper with lead? Thus copper is unacceptable because lead is unacceptable! The point is that Mr. Cardoza relies on comparisons with other plastic pipe to support his argument for the need to have a CEQA review of PEX piping.

Further to the third item, Mr. Cardoza's reference to the problems with polybutylene (PB) piping should not be applied to PEX. PEX is a crosslinked product. PB is not. The problems with PB are well known, and believe me, contractors in the country are using PEX because they are totally convinced that PEX does not have the problems of PB. PEX has been used extensively in Europe for the past 15+ years and in this country for the past 10 years. The PB problems have not been experienced with PEX. Go to Charlotte, NC (another rapidly growing area) and you will see PEX in almost all-new construction.

Again in reference to item three, PEX comparison with CPVC is wrong. Mr. Cardoza provides an extensive dialog about the problems with the chloroform and other chemicals that leach into the drinking water; and the problems with worker and consumer exposure to toxic chemicals used to "weld" the pipe together. First, PEX is not a chlorinated product. No chlorine ions are present in PEX. Second, PEX does not use any solvents to weld the joints. PEX uses a mechanical joint with a clamping support ring on the outside of the pipe. Again, PEX is a plumbing system that uses NO toxic solvents. Mr. Cardoza could

have referenced the many studies that address the same issue with the use of toxic chemicals in flux and solder used to "weld" copper plumbed systems.

Fourth, Mr. Cardoza's reference to the threshold question as to whether or not the proposed approval of PEX constitutes a "project" within the meaning of CEQA. Restated herein, under CEQA, a "project" is the whole of the action that has the potential for resulting in a direct or reasonably foreseeable indirect change in the physical environment. Because of the wide acceptance of PEX, and its inclusion in the Uniform Plumbing Code 2000 edition, I submit that the use of PEX does not constitute a "project" under CEQA. The International Association of Plumbing and Mechanical Officials (IAPMO) is an organization that has extensively studied and approved PEX. Please be reminded that the full body of information and evidence that PEX has no adverse environmental impacts, and that PEX is a major contribution to the advancement of an environmentally safe product, is supported by the membership of IAPMO, including:

National Association of Plumbing-Heating-Cooling Contractors (NAPHCC)
Mechanical Contractors Association of America (MCAA)
American Society of Sanitary Engineers (ASSE)
United Association of Journeyman Apprentices of the Plumbing and Pipe Fitting Industry (UA)
Western Fire Chiefs Association (WFCA)
National Fire Protection Association (NFPA)

These organizations would not have approved PEX if the net effects were adverse environmental impacts.

Fifth, Mr. Cardoza's attack on NSF International as an unworthy organization to represent the safety of plumbing products is totally unfounded and biased. Mr. Cardoza uses "Disclaimers" in NSF statements as reasons why NSF can not be used. Mr. Cardoza, as an attorney, fully understands why NSF must have these disclaimers. NSF is a private organization, not connected with any manufacturing company. All standard setting bodies have this wording in their offerings. Without these disclaimers, NSF would be subjected at all types of lawsuits that would have to be defended. Does the Council provide any warrantees or acceptance of responsibilities? We know the answer. Even if California completed an EIR, the State would not bear any responsibility for safety or performance. The credibility of NSF resides in its structure, its history and experience, and its protocol for testing, validation, and ongoing certifications. Please be reminded that NSF not only does the testing for acceptance and certification, but it also requires annual inspections for ongoing compliance. If NSF cannot be trusted, who, in the state of California will monitor requirements of manufacturing facilities? This is true for copper pipe manufacturing, for fittings, for solvents, and others; as well would be the requirement for PEX pipe and fittings. I have had experience with NSF, and I have always found them to be of the highest integrity and professionalism. I'm sure the Commission would find the same.

Sixth is the issue of fire safety. Mr. Cardoza suggest the Department of Housing and Community Development (HCD) seek comment by California fire officials on the likely efficacy on the proposed prevention mechanisms related to PEX, particularly in light of the high seismic activity and associated risk of structure fire in most of the state. First, I would remind the Commission that the Western Fire Chiefs Association (WFCA) has endorsed the use of the UPC as the national plumbing for use in this country and internationally. Also, the National Fire Protection Association (NFPA) and IAPMO announced at the September 1999 Conference that NFPA will work jointly to develop IAPMO codes and standards using the NFPA/ANSI consensus model. This is the model used in the approval of PEX. Second, related to the fire issue. PEX offers an advantage because no open flame is used to connect joints.

Another significant point related to Mr. Cardoza's concern about failures due to seismic activity is that PEX is a flexible piping system. It will not rupture easily due to the affects of seismic activity. In fact, this could be a major benefit of PEX. For example, copper installed in concrete will rupture with minor shifts. PEX will not rupture as easily. Again, advantages and drawbacks of different piping systems. All of these were considered in adoption of the UPC 2000 Edition.

Benefits for the Application of PEX Piping Systems in California

Health and Safety

PEX Piping Systems do not expose workers to toxic chemicals. Other approved systems do: Copper with vaporized flux. Flux contains several chemicals that are very toxic, including zinc chloride. The proper use of flux requires a well-ventilated area. If not, workers can severely damage their lungs. Do you believe all areas are well ventilated during installation? CPVC with the vaporized "welding" solvent. The solvent also contains very toxic and hazardous chemicals, including tetrahydrofuran (THF), and methylethylketones (MEK). The PEX mechanical, ring, clamping system uses only a mechanical tool to connect joints.

Because PEX does not use any flux or solvents to connect the joints, no chemicals are available at the joints to contaminate the water supply. NSF has tested and proven that PEX piping systems do not contain any toxic or hazardous chemicals to leach into the water supply.

Some areas of California currently allow PEX as an alternative to copper. These municipalities have needed an alternative like PEX because of the failures of copper systems. In Riverside County for example, there are some homes that have to be repiped after only 5-10 years due to chemical corrosion of the copper pipe. When the corrosion occurs, many deleterious chemicals are carried away in the water supply. A recent study in the Journal of American Water Works Association, November 2001, identifies many of these metallic chemicals that release cupric ions are malachite ($CuCO_3Cu(OH)_2$, Cuprite (Cu_2O), brochantite ($Cu_4(OH)_6SO_4$, tenorite (CuO). The point here is that chemicals that are present in some water supplies attack copper resulting in metallic contamination of the water, and failure of the piping system.

Again, residents of California should have the option to purchase plumbing systems other than metallic.

Energy Conservation

There are two positive energy saving benefits of PEX. The first is in the manufacture of the materials. The energy it takes to mine, purify, and extrude copper pipe is about 100,000BTUs (British Thermal Units) per pound. PEX takes about 20,000BTUs (including the energy value of the materials) per pound. This comparison is even more favorable because of the weight difference per foot of pipe. 1000 ft of 1" copper pipe weights about 839 pounds. 1000 ft of PEX pipe weights about 175 pounds. Therefore, the energy used to manufacture the 1000 feet of pipe is about 839,000,000 BTUs for copper and about 3,500,000 for PEX, more than 30 times more energy for copper compared to PEX per running foot of pipe.

The second energy savings are a result of the insulation value of PEX compared to copper. Copper is a very good conductor of heat. PEX is not. Therefore, PEX pipe acts like an insulator when conducting hot water to fixtures. Copper's thermal conductivity is 227BTU/oF/ft2/ft compared to 0.5 for PEX, e.g. 500 times greater. Hot water flowing through the copper will cool down faster and lose more heat than the heat lose of water flowing in PEX pipe. Because of this difference, water heaters can be set about 5 degrees Fahrenheit lower to achieve the same water temperature at the fixture (this saves on the life of the water heater also). Estimates show average savings per household of about 5mmBTU/yr. If the water were heated with electricity, the savings would be in the range of $50-$100/yr.

As we all are aware, energy savings in California are paramount. Governor Gray Davis has made energy conservation a primary goal of his administration. Californians should have the option to purchase PEX plumbing systems.

Valuable Raw Materials

Copper is a high value raw material. The US is a net importer of copper from countries like Peru, Brazil, and Argentina. There are limited supplies of copper in the world.

On the other hand, PEX is a manufactured product, mostly from ethylene extracted from natural gas and petroleum refining operations. PEX can be manufactured from coal products as well. These are low value raw materials that are enhanced in manufacturing plants, mostly in the US.

In the future, we can expect the price of copper to increase faster than PEX. If we are faced with another major energy crisis, and the price of energy and raw materials go up significantly, California would be straddled with the high cost of copper and the energy it takes to produce i.e. without the option to use PEX.

Direct Cost Savings to California Consumers

PEX piping systems would save consumers several hundred to thousands of dollars for new home construction. The savings are in the materials and labor.

In addition, many homes are being repiped due to metallic piping system failures. Repiping with PEX is significantly more cost effective than repiping with rigid pipe. PEX can be "snaked" through areas that are impossible to reach with rigid pipe. Sometimes this means the difference between a complete remodeling project and just the pipe replacement. Again, Californian's should have this option.

Millions of homebuyers have been the beneficiaries of these savings across the country.

Conclusion

PEX piping systems have been extensively studied and proven to be a net benefit to consumers and the plumbing industry. Prior to the adoption of the UPC 2000 Edition, the many reputable organizations represented by IAPMO studied all environmental and safety aspects in the use of PEX. The NSF, ANSI, UL, City of Los Angles, IPC, ICBO, BOCA, NSPC, CABO, NSPC and others have tested and retested PEX, resulting in approved listings of PEX as an optional plumbing material for hot and cold water use.

Millions of homes have been, and are currently being, plumbed with PEX in the US; some in California because of problems with metallic system failures, and some because informed citizens are concerned about deleterious affects of metallic contamination. Polyethylene is approved as a building material for many applications. PE, identical to PEX except for the molecular crosslinking, is the most widely used material for packaging foods.

Mr. Cardoza refers to the position taken by the State in the early 1980's requiring an EIR before approval of any plastic piping system in California. I submit this may have been a correct position in the 1980's. Since then however, the body of evidence generated, and the positive experience in both the US and Europe, for PEX plumbing systems is overwhelming in favor of PEX as an option to other plumbing systems. The UPC allowed PEX in the 2000 Edition after extensive studies and experience.

I submit the Commission would be doing a disservice to the consumers of California by not allowing PEX as an option in the Code. It would mean that one organization, with the obvious incentive to benefit their constituents, has caused Californians not to have the option to what could very well be the best alternative for plumbing. I believe plumbers and contractors should have the right to choose PEX, especially if they believe the other systems may cause long-term health problems. I believe Californians should have the option of an all-plastic plumbing system if they have concerns about metallic contamination.

Gentleman, I think I have addressed the issues raised by Mr. Cardoza. As Mr. Cardoza states on page 40 (comments from the previous public comment period), the threshold question is whether the proposed approval of PEX constitutes a "project" within the meaning of CEQA. A CEQA would take into consideration the positives and negatives of competing plumbing systems. The problems I refer to for copper and CPVC are real. This is not an argument to remove copper and CPVC from the code (although the evidence is just as valid as Mr. Cardoza's is for PEX): only to provide evidence to support why PEX should be an option. I believe the body of evidence available today from all the sources referenced above, support that this is not a project that should trigger a CEQA. This may have been the case several years ago...before the 10 years of experience...before the evaluation, testing, and reviews prior to adoption of the UPC 2000 Edition; but not today. Californians should have the option to choose PEX.

Thank you for the opportunity to submit these comments. I'm confident the Commission will make the correct decision for all Californians.